

Parallel Outcomes

Comparing Effects of Environmental Contaminant Exposures with ADHD in Children

Attention deficit/hyperactivity disorder (ADHD), the most frequently diagnosed neurobehavioral disorder in children, affects more than 5% of the population worldwide. Although the etiology of ADHD is poorly understood, characteristics similar to those seen in children with ADHD also have been observed in



children and animals exposed to lead or polychlorinated biphenyls (PCBs). Two literature reviews in this issue provide an overview of ADHD diagnostic criteria and explore the parallels between behavioral test results from children with ADHD and findings from children and laboratory animals with developmental exposure to lead or PCBs [EHP 118(12):1646–1653; Aguiar et al.; EHP 118(12):1654–1667; Eubig et al.]. The authors conclude that exposure to these environmental contaminants, and possibly others, may increase the prevalence of ADHD.

Deficits in executive function and attention are key characteristics of both ADHD and developmental exposure to lead and PCBs. Executive function

encompasses cognitive abilities critical to goal-oriented problem solving, such as working memory, response inhibition, cognitive flexibility (the ability to mentally “switch gears”), and planning.

Do Metals Meddle with Puberty in Girls?

Lead, Cadmium, and Altered Hormone Levels

Lead and cadmium are both known reproductive toxicants. Now researchers have identified a link between relatively low levels of these metals and hormone markers of delayed onset of puberty in girls [EHP 118(12):1782–1787; Gollenberg et al.].

A team of scientists led by researchers at the National Institute of Child Health and Human Development used blood samples collected from girls aged 6–11 years as part of the nationally representative Third National Health and Nutrition Examination Survey, conducted by the Centers for Disease Control and Prevention (CDC) between 1988 and 1994. The team measured concentrations of two reproductive hormones—inhibin B and luteinizing hormone—that serve as markers of hypothalamic, pituitary, and gonadal functioning.

Associations with lead were estimated for luteinizing hormone in 671 girls and inhibin B in 655 girls. Most of the girls whose hormones were measured had blood lead levels below the CDC’s 10- $\mu\text{g}/\text{dL}$ action level. The median blood lead level was 2.5 $\mu\text{g}/\text{dL}$, and less than 20% of the girls had blood lead levels exceeding 5 $\mu\text{g}/\text{dL}$. The median urinary cadmium concentration was 0.12 ng/mL (the authors considered levels over 0.27 ng/mL to be high). Non-Hispanic black girls had higher age-adjusted

Attention revolves around alertness (the ability to become alert and focus on a task) and vigilance (sustained alertness).

ADHD has a strong genetic component but, like other neurodevelopmental disorders, appears to involve interactions between genetic, environmental, and social factors. Neuroimaging studies in children with ADHD have revealed alterations in brain regions that control executive function and attention, such as the prefrontal cortex. Alterations in catecholamine neurotransmitter signaling also are present in children with ADHD. Such signaling is potentially susceptible to damage by environmental toxicants.

Developmental exposure to lead has been widely studied and is known to have a negative impact on cognitive function as well as on children’s behavior. Across studies, cognitive flexibility, vigilance, and alertness appear to be the functions most consistently affected by lead, but evidence also exists for negative effects on working memory, response inhibition, and planning. Several studies have reported associations between blood lead levels in children and ADHD.

In contrast, researchers are only just beginning to explore the relationship between PCB exposure and ADHD diagnosis. Developmental exposure to PCBs is known to affect cognitive functions including working memory, response inhibition, cognitive flexibility, and alertness, although there appears to be little if any impact on vigilance. Animal studies further show that both lead and PCBs can reduce dopamine (a catecholamine) signaling in the prefrontal cortex of the brain.

Although levels of lead and PCBs have declined overall in the environment and in our bodies, they remain public health issues. A better understanding of their roles in ADHD and other neurodevelopmental disorders is needed, and this knowledge could be useful in investigating other environmental agents including brominated flame retardants, bisphenol A, phthalates, organophosphate pesticides, and polyfluoroalkylated chemicals, all of which have been suggested by recent research to possibly be associated with ADHD.

Julia R. Barrett, MS, ELS, a Madison, WI–based science writer and editor, has written for *EHP* since 1996. She is a member of the National Association of Science Writers and the Board of Editors in the Life Sciences.

levels of both lead and cadmium than non-Hispanic whites or Mexican Americans.

The researchers found no significant associations with luteinizing hormone. However, girls aged 10 or 11 with blood lead levels of 5 $\mu\text{g}/\text{dL}$ or higher were 75% less likely than girls with blood lead under 1 $\mu\text{g}/\text{dL}$ to have levels of inhibin B greater than 35 pg/mL , a level typically deemed consistent with puberty by the limited research in this area. The researchers also found proportionately lower levels of inhibin B in girls who had relatively high levels of both cadmium and lead, compared with girls who had only high lead. Moreover, after adjusting for age, inhibin B levels were lowest for iron-deficient girls with blood lead levels of 1 $\mu\text{g}/\text{dL}$ or higher, suggesting that lead may be particularly toxic for girls with iron deficiency.

The authors conclude that lead may suppress the production of hormones associated with puberty, especially in concert with cadmium. They stress that, on a national scale, changes in the timing of onset and/or progression of puberty can have considerable public health and social implications for both boys and girls. For instance, relatively late-maturing girls are at risk for diminished bone strength and fragility fractures later in life. The hormone alterations linked to lead and cadmium exposure in the study also could have other as-yet unknown effects.

Kellyn S. Betts has written about environmental contaminants, hazards, and technology for solving environmental problems for publications including *EHP* and *Environmental Science & Technology* for more than a dozen years.